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Engineering Study: Dual-Purpose Canister/Waste Package Cutting Machine Design Development Plan

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DUAL-PURPOSE CANISTER/WASTE PACKAGE CUTTING MACHINE DESIGN DEVELOPMENT PLAN

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ACRONYMS

DDP	design development plan
DPC	dual-purpose canister
FMEA	failure mode and effects analysis
FTA	fault tree analysis
HLW	high-level radioactive waste
ITS	important to safety
I&C	instrumentation and control
NSDB	*Nuclear Safety Design Bases for License Application*
SNF	spent nuclear fuel
SSCs	systems, structures, and components
WP	waste package

1. PURPOSE

The purpose of this design development plan (DDP) is to identify major milestones for advancing the design of the dual-purpose canister (DPC) cutting machine to meet its credited safety functions, as identified in *Nuclear Safety Design Bases for License Application* (NSDB) (BSC 2005), where this objective cannot be achieved by the use of commercially available components or the application of industry consensus codes and standards. Furthermore, this DDP defines the planned approach and schedule logic ties for the design development activities, if and when required, and provides a basis for the subsequent development of performance specifications, test specifications, and test procedures.

2. SCOPE

The scope and extent of this DDP are primarily driven by the development requirements defined within the *DPC Cutting Machine—Gap Analysis Table* (COGEMA 2005b). This DDP applies to areas of the DPC cutting machine design where performance confirmation cannot be readily obtained through the use of standard systems, structures, and components (SSCs) (e.g., cranes) or consensus codes and standards.

The scope of this DDP is limited to identifying the planned approach and design development activities necessary to advance the design of the DPC cutting machine to demonstrate that it will meet its credited safety functions. Thereafter, this DDP will form the basis for defining design development and testing requirements within the DPC cutting machine performance specification. The performance specification will define the codes and standards and performance requirements for the design, fabrication, and testing of the equipment. Thereafter, testing activities will be detailed in test specifications and test procedures. Test specifications will detail the requirements for each test, and testing procedures will prescribe how each test is to be performed.

The planned approach and design development activities identified within this DDP may also apply to the waste package cutting machine. The current revision of the NSDB (BSC 2005) does not include any nuclear safety requirements for the waste package cutting machine. The waste package cutting machine will perform essentially the same function as the DPC cutting machine. The waste package cutting machine may differ in cutting techniques used; however, the design development identified in this DDP should be applicable. Therefore, the conclusions of this DDP can also be applied to the waste package cutting machine.

This DDP is prepared by the Spent Nuclear Fuel (SNF)/High-Level Radioactive Waste (HLW) Transfer System Team and is intended for the sole use of the Engineering department in work regarding the DPC cutting machine. Yucca Mountain Project personnel from the SNF/HLW Transfer System Team should be consulted before use of this DDP for purposes other than those stated herein or by individuals other than those authorized by the Engineering department.

3. PROGRESSIVE APPROACH

A practical design philosophy has been adopted relying on proven concepts and technology used by other similar nuclear facilities. Design development requirements and activities identified within this plan are commensurate with the level of design completed for License Application and the associated gap analysis study. Accordingly, specific design details, or the selection of SSCs, may not be known, and all design development requirements may not have been identified within the gap analysis study.

For this reason, within this DDP, a progressive design development approach is presented that provides a framework whereby design development requirements and activities can be identified and detailed as the design advances. However, as the design advances, it is anticipated to the extent practical that components or SSCs that perform ITS functions will be selected based on proven technology and codes and standards that provide assurance that they will perform, as required, without need for extensive design development.

This progressive design development approach includes, as appropriate, the design development activities identified in Section 9. Completion of each design development activity and advancement of the design will determine the need for further design development and completion of additional design development activities.

This progressive approach will maintain flexibility throughout the design process to allow alternative solutions to be explored without compromising project design development objectives.

4. DESIGN DEVELOPMENT OBJECTIVES

The primary objective of this DDP is to identify the activities that extend beyond the codes and standards and supplemental requirements specified in *DPC Cutting Machine—Gap Analysis Table* (COGEMA 2005b) and are utilized in advancing the design of the DPC cutting machine to meet its credited safety functions.

5. QUALITY ASSURANCE

This document was prepared in accordance with LP-ENG-014-BSC, *Engineering Studies*. The results of this document are only to be used as the basis for selecting design development activities; they are not to be used directly to generate quality products. Therefore, this engineering study is not subject to the requirements of *Quality Assurance Requirements and Description* (DOE 2004).

6. USE OF COMPUTER SOFTWARE

The computer software used in this study (Microsoft Word 2000) is classified as exempt from procedure LP-SI.11Q-BSC, *Software Management*. All software used to prepare this analysis is listed as software not subject to this procedure (LP-SI.11Q-BSC, Section 2.1).

7. FUNCTIONAL DESCRIPTION

The DPC cutting machine is in the conceptual design stage along with the entire DPC cutting system. Because of this, certain assumptions concerning operation must be made. A list of assumptions with rationale is detailed in *DPC Cutting Machine—Gap Analysis Table* (COGEMA 2005b). Various cutting techniques and their applicability are detailed in *DPC and*

WP Cutting Study Report (COGEMA 2005a). The DPC cutting system is designed to perform the following functions:

- Dock a cask containing a DPC to the DPC cutting/WP dry remediation cell (Room 1097).
- Transfer DPCs within room 1097 to the cutting station and unloading area.
- Sample the DPC cavity and vent.
- Open the DPCs to allow the transfer of SNF.
- Prepare the unloaded DPC for processing as low-level radioactive waste.

The DPC cutting system is a subsystem of SNF/HLW transfer system operations in the Dry Transfer Facility. The DPC cutting machine is located in the DPC cutting/WP remediation cell (Room 1097). The DPC cutting machine is located in a contaminated and high radiation area. Control and monitoring of the DPC cutting machine is performed remotely from the adjacent DPC cutting/WP remediation work station (Room 1098). Maintenance is performed remotely in the cell or manually in the crane park cell. There is personnel access to the crane park cell for machine maintenance.

Major components used by the DPC cutting system include:

- 100-ton waste package remediation crane
- DPC cutting machine
- DPC cutting station
- Power cutting shear
- DPC grapple or lifting yoke
- WP/DPC trolley
- DPC overpacks
- DPC stands
- Master slave manipulators
- Tools for remote maintenance
- DPC docking station
- DPC/waste package transfer hatch.

The DPC is a permanently sealed container of a complex all-welded construction that can only be opened in a destructive manner by a cutting machine. The DPC designs vary widely in terms of physical characteristics and details of arrangement.

8. NON-STANDARD SSCs

Non-standard SSCs are defined as SSCs that are not based on commercially available equipment, established industry practices, or consensus codes and standards. Non-standard SSCs and custom mechanisms whose failure modes may not be fully understood will need an investigation to determine the correlations to standard SSCs and if additional testing is needed to validate the assumptions. The majority of SSCs, mechanisms, and assemblies may appear non-standard; however, when broken down to a subcomponent level, they are often composed of standard component parts.

The preferred components are standard components whose failure modes and associated effects are well understood within industry and have their assigned reliability values documented. However, if subjected to an environment that is alien to their normal operation, such as radiation, contamination, and elevated temperatures, accelerated wear and failures could be encountered. Potential exposure to extreme seismic loads could affect standard equipment qualification. Determining a conservative derating factor to be attributed to the values normally assigned may need further investigation and validation.

Design confirmation of a non-standard SSC may be performed through various methods depending on the nature of the SSC. Some common examples include solid modeling, finite element analysis, and bench testing.

The *DPC Cutting Machine—Gap Analysis Table* (COGEMA 2005b) identifies SSCs that perform ITS functions and the codes and standards to be used in the design, fabrication, and testing of the SSCs to provide assurance that they will perform as required. Supplemental requirements are identified in the gap analysis table when requirements for the SSCs extend outside the scope of the codes and standards.

The DPC cutting machine is in the conceptual design stage, and there are currently no non-standard SSCs identified in the design. However, non-standard SSCs may be specified as the design progresses. The design development activities described below may be applied to both standard and non-standard SSCs as needed.

9. DESIGN DEVELOPMENT ACTIVITIES

If a design development requirement is identified, the following design development activities represent the progressive design development approach to advance the design of the DPC cutting machine. In turn, as the design advances, the need to complete each design development activity or selectively complete activities should be determined based on meeting each credited safety function. Design development activities are described in Section 10.

- Design Activities
  - Selection of SSCs
  - Engineering calculations
  - Computer modeling
  - Failure mode and effects analysis (FMEA)
  - Fault tree analysis (FTA)

- Testing Activities
  - Bench testing of components
  - Prototype testing
  - Integrated testing.

Prototype testing is identified as a design development requirement in the *DPC Cutting Machine—Gap Analysis Table* (COGEMA 2005b). This design development requirement is presented in Appendix A and discussed in Section 10.7. Although proven technologies and adaptations of similar designs will be used to the extent practical, additional design development requirements may be identified in the future.

10. DESIGN DEVELOPMENT ACTIVITY DESCRIPTIONS

Based on the current design of the DPC cutting machine, one design development requirement has been identified. Many of the activities described in this section are not applicable to the DPC cutting machine but are included to accommodate design development needs that may be identified in the future.

10.1 SELECTION OF SSCs

To the extent practical, SSCs should be selected based on proven technology with demonstrated performance in similar environmental and operational conditions. SSCs with a proven nuclear pedigree and known and well-documented history may significantly reduce the need for subsequent design development. The selection of new technologies could require testing to confirm the adequacy of the SSC design under normal, abnormal, design basis event, post-design basis event conditions, and the suitability of materials and methods of construction.

10.2 ENGINEERING CALCULATIONS

The structural, mechanical, instrumentation and control (I&C), and electrical design of the DPC cutting machine will be developed in compliance with the codes and standards and supplemental requirements identified in *DPC Cutting Machine—Gap Analysis Table* (COGEMA 2005b). The design process also allows for other codes and standards to be used, upon approval, with the use of new SSCs proposed to satisfy the safety requirements.

If, during the structural and mechanical design tasks, necessary evaluations are identified that are outside the identified codes and standards, a design development activity may be performed. General assembly drawings may be developed, and applicable SSCs will be evaluated through engineering calculations.

The design progression will determine if additional engineering calculations are required to satisfy the safety requirements.

10.3 COMPUTER MODELING

If necessary, computerized simulation program (3D) modeling may be conducted for design confirmation during the evolution of the DPC cutting machine design to ensure the SSCs perform ITS functions without interference. Interfaces between DPC cutting machine SSCs and interfaces with other SSCs will be evaluated for acceptable performance during the design activities in conjunction with the codes and standards identified in *DPC Cutting Machine—Gap Analysis Table* (COGEMA 2005b).

The DPC cutting machine interfaces with the following equipment or systems may include ITS functions:

- Overhead crane
- Below-the-hook lifting devices for the DPC cutting machine
- DPCs
- DPC grapple or lifting yoke
- Electrical power system.

Finite element modeling may also be used as a design development activity to provide supporting evidence that design stress levels are not exceeded, especially for complex components.

The design progression will determine if additional computer modeling is required to satisfy the safety requirements.

10.4 FAILURE MODE AND EFFECTS ANALYSIS

A FMEA may be performed using ANSI/IEEE Std 352-1987, *IEEE Guide for General Principles of Reliability Analysis of Nuclear Power Generating Station Protection Systems.*

When identified as a design development activity, the FMEA is usually the first reliability activity performed to provide a better understanding of a design's failure potential. It can be limited to a qualitative assessment, but may include numerical estimates of a failure probability. Important applications of the FMEA include the following:

- Specification of future tests that is required to establish if or not design margins are adequate relative to the specific failure mechanisms that have been identified in the FMEA.

- Identification of acceptable versus unacceptable failures for use in the quantitative evaluation of safety-related reliability.

- Identification of critical failures that may dictate the maintenance philosophy and frequency of operational tests or maintenance intervals if these failure modes cannot be eliminated from the design.

- Establishment of the level of parts quality (particularly true in electrical systems) needed to meet allocated reliability goals.

- Identification of the need for design modifications to eliminate unacceptable failure mechanisms. These failures could produce unacceptable safety or operational conditions.

- Identification of the need for failure detection.

The FMEA may be used to identify, by component, all known failure modes, failure mechanisms, effects on the system, methods of failure detection, and what provisions are included in the design to compensate for the failure. The analysis should provide established reliability statistics based on failure rates for components used in similar applications and environmental conditions. Reliability data, where available, will be obtained from facilities with similar quality control requirements. This activity is a prerequisite to performing a detailed FTA and provides the first level of design confirmation during the conceptual design phase. Where data cannot be obtained from sources that reflect comparable environmental exposure the bench testing results should be used to adjust, where necessary, the reliability values for individual components. The FMEA should be periodically updated to reflect changes as the design matures.

10.5 FAULT TREE ANALYSIS

A FTA may be performed using ANSI/IEEE Std 352-1987.

When identified as a design development activity, the FTA is used to ensure that the SSCs will perform their intended safety functions with the reliability required by the NSDB either explicitly or implicitly. A FTA, when used in conjunction with the results of a FMEA and potential bench testing, should provide adequate design confirmation to make the decision if to proceed with prototype testing or offsite integrated testing or both. Alternatively, any negative FTA results may indicate that the design (either preliminary or detailed) needs to be further revised for the SSC to meet the established safety requirements.

Important benefits of FTA are:

- Identify possible system reliability requirements and needs or failure faults during design.
- Assess system reliability or safety during operation.
- Identify components that may need testing or more rigorous quality assurance scrutiny.
- Identify root causes of equipment failures.

The design progression will determine if additional FTAs are required to satisfy the safety requirements.

10.6 BENCH TESTING OF COMPONENTS

Bench testing has not been identified for any DPC cutting machine SSCs. The design progression will determine which SSCs require bench testing to satisfy the safety requirements.

10.6.1 Purpose of Bench Testing

The purpose of bench testing is to provide confirmation and reassurance that appropriate values are being used in the FMEA and FTA performed on the detailed design. Components that do not have a proven history for operating in a similar environment shall be considered for bench testing.

10.6.2 Bench Testing Requirements

Bench testing shall be performed at a testing facility capable of handling the testing environment to demonstrate that each component is capable of performing its safety function under representative environmental conditions. Environmental conditions should be established based on bounding relevant environmental conditions while under loads representative of the bounding load combinations. Testing shall be in a nonradioactive environment unless necessary.

The development of test plans and procedures is not detailed in this description but is mentioned as a necessary step for each phase of bench testing.

10.6.3 Rationale for Selecting Components for Bench Testing

Bench testing can be applied to components, assemblies, or the entire piece of equipment. The selection of these components should consider their influence on test results. Where practical, components that are identified as ITS shall be identical to those used in the final production unit.

Components that do not have a proven history of operating within a similar environment should be subject to bench testing. In order of priority, the following list identifies those components that should be tested:

1. Novel components with no nuclear pedigree

2. Environmentally sensitive components (such as unshielded electronics)

3. Methods or techniques used in the construction or operation of components

4. Standard components whose unique configuration exposes them to potentially unknown failure modes in the unique environment.

10.7 PROTOTYPE TESTING

Prototype testing is identified for DPC cutting machine mechanical and I&C SSCs. During the design progression, a complete list of SSCs requiring prototype testing to satisfy the safety requirements will be determined.

Based on the conceptual design, prototype testing is anticipated to verify that the DPC cutting machine will preclude a radiological release due to damage inflicted upon the DPC contents during the cutting process. The specific tests and applicable SSCs have not been fully determined.

During fabrication it may be necessary to demonstrate the functionality of other SSCs to confirm that the ITS functions perform as required. Prototype testing can be applied to individual components, assemblies, or the entire equipment. The basic approach is to test the critical systems in an environment that simulates the actual operating environment as closely as possible. The development of test plans and procedures will ensure the ITS functions are tested in the relevant conditions and that the required performance is monitored.

Recognizing that for some instances there may be restrictions on the physical size and capacity of test facilities available, it may be more appropriate to test at the component level rather than testing entire assemblies. Also, for some instances more meaningful, data and information may be obtained by tests at the component level. Selection of individual components should consider their influence on test results. Where practical, components that are identified as ITS should be identical to those to be used in the final production unit.

Prototype testing may be performed in the following sequential phases to the extent required to meet acceptance criteria:

1. Phase I: Accelerated Testing
2. Phase II: Extended Testing
3. Phase III: Sustained Testing.

10.7.1 Accelerated Testing

Accelerated testing should simulate the full life-cycle operations of the component or assembly for identified parts (e.g., controllers, switches, sensors, and bearings) under representative operating conditions. Life-cycle operations should be based on all normal movements associated with the throughput of the equipment as described in the system description document and should take into account the anticipated replacement frequency.

Appendix B is used to tabulate ITS SSCs and prototype accelerated tests. Only the cutting process SSCs are currently identified for prototype testing.

10.7.2 Extended Testing

Extended testing should simulate extended life-cycle operations for ITS moving parts of the DPC cutting machine or components (e.g., motors and speed controllers) under representative operating conditions. Extended life-cycle operations should be based on all normal movements associated with the SSC operational cycles, plus margin for the operating period of the component prior to replacement.

Appendix B is used to tabulate ITS SSCs and prototype extended tests. The prototype testing for the cutting process SSCs are not anticipated to include extended testing.

10.7.3 Sustained Testing

Sustained testing should simulate the performance of the DPC cutting machine or its components under off-normal environmental and operating conditions. Off-normal conditions should include, but are not limited to, temperature extremes, over speed, over travel, collisions, off-set loads, loss of power, and misalignment.

The anticipated frequency of the off-normal events should drive the number of cycles a test is performed. For example, the seismic qualification of a component need only be tested using either a static equivalent force applied over an hourly period or a time history of the forces derived from analysis. Off-normal temperature conditions, perhaps caused by heating, ventilation, and air-conditioning system failure, may warrant a test whose duration matches the mean time to repair the heating, ventilation, and air-conditioning system.

Sustained testing may be performed at the end of extended testing. This will provide confidence that the SSCs will perform as designed during off-normal events even at the end of their intended lifecycle, to account for the effects of normal or extended wear and tear.

Damage or malfunction of the SSCs during sustained testing may require that the design be revised (if the SSCs do not meet the intended safety requirement) or repaired or replaced if the damage is minor and does not impact the intended safety function. This would only be necessary if multiple and sequential sustained tests are envisioned. The repaired or replaced component may then have to undergo another cycle of accelerated and extended testing prior to the next sustained test.

Appendix B is used to tabulate ITS SSCs and prototype sustained tests. The prototype testing for the cutting process SSCs is not anticipated to include sustained testing.

10.8 OFFSITE INTEGRATED TESTING

Following fabrication and the manufacturer's tests and inspections, offsite integrated testing may be necessary to demonstrate and confirm that the ITS functions and interfaces perform as required. To the extent practical, the offsite integrated testing may be used to demonstrate the performance of the ITS SSCs under simulated operational conditions, including each type of DPC the machine is designed to cut. The development of test plans and procedures will ensure the ITS functions are tested in the proper conditions and that the required performance is monitored.

The testing may be specified to support the following:

- Demonstrate ITS functionality of the system under simulated operational conditions.
- Permit early hands-on involvement of regulatory agencies.
- Permit early operator training capabilities.
- Provide early feedback for needed modifications or design enhancements.

The design progression will determine if offsite integrated testing is required to satisfy the safety requirements.

10.9 OPERATIONAL READINESS REVIEW

Although operational readiness review is beyond the scope of this DDP, it is mentioned here for completeness. The operational readiness review should follow offsite integrated testing and highlights the final milestone in demonstrating the performance of production ITS SSCs.

11. INFORMATION COLLECTION AND INSPECTION REQUIREMENTS

The primary objective of information collection and inspection requirements is to document the performance of the design. Component failure or excessive wear may be influenced by interactions. Thus, to evaluate component failures that influence reliability, it is essential that information be collected during each stage of the component life (i.e., manufacture, construction, testing, and operation). This information may then be used to ensure that a root cause analysis can be performed on those components that do not meet their intended design and performance objectives.

Appendix C is used to identify typical ITS SSCs data collection requirements. No data collection activities beyond those required by the codes and standards and supplemental requirements have been identified for any DPC cutting machine SSCs. As the design progresses, data collection requirements may be identified for prototype testing and cutting process ITS SSCs.

11.1 BASELINE DATA

To assess wear and failure modes of ITS components during and after testing, it may be essential that detailed baseline data be obtained. The data, at a minimum, should include a physical inspection of each component before and after testing to identify defects and anomalies. Typical data should include weights, key dimensions, and surface finishes.

11.2 ACCELERATED TEST DATA

Throughout life-cycle prototype testing, sufficient instrumentation may be utilized to monitor the performance of ITS components. Instrumentation should provide real-time monitoring and feedback on key measurement and operating parameters. Measurements, as a minimum, should include temperature, loads, speed, and travel, depending on ITS safety functions to be verified and physical parameters to be monitored. Instrumentation, where practical, should include visible and audible feedback.

During accelerated testing, components may be inspected and maintained (adjusted or lubricated) as part of a scheduled maintenance regime based on vendor data. Where practical, vendor data should be supplemented with predictive maintenance and condition monitoring techniques.

11.3 EXTENDED TEST DATA

Data requirements for extended testing are similar to those for accelerated testing, with the exception that a detailed inspection of each ITS component needs to be performed prior to testing to determine component compliance with specifications, wear and life expectancy.

11.4 SUSTAINED TEST DATA

Data requirements for sustained testing are similar to those for accelerated testing, with the exception that a detailed inspection of each ITS component needs to be performed after each sustained test evolution to monitor for the evidence of progressive and cumulative fatigue or component failure.

11.5 OFFSITE INTEGRATED TEST DATA

Following fabrication, including the manufacturer's tests and inspections and, where applicable, the prototype testing of SSCs, it may be necessary to demonstrate the overall functionality of the ITS functions. This phase of testing is referred to as integrated testing. To the extent practical, integrated testing will be used to demonstrate the performance of the complete system under simulated operational conditions. Prior to offsite integrated testing, equipment used should be refurbished or replaced to a new condition. Data collection for integrated testing should be representative of real operations. Test conditions should also be representative, with the exception of the presence of a radiation source. Where possible, interfacing SSCs should be included in the final stages of testing to prove, where in doubt, that the integration of various components operate as intended. When determined necessary, integrated testing is recommended to support meeting the following goals:

- Demonstrate ITS functionality of the complete system under simulated operational conditions.
- Demonstrate practicality of recovery and retrieval plans (when applicable).
- Permit early hands-on involvement of regulatory agencies.
- Permit early operator training capabilities.
- Provide early feedback for necessary modifications or design enhancements.

12. EXPECTED RESULTS AND ACCEPTANCE CRITERIA

The following subsections outline the generic expected test results and acceptance criteria based on satisfying the ITS requirements specified in the NSDB (BSC 2005). Reported deviations from these expectations should be subject to close inspection and further evaluated. If necessary, additional testing may be required to verify data or provide additional information to enable a conclusive root cause analysis to be performed.

12.1 ACCELERATED TESTING

The completion of accelerated testing will demonstrate the satisfaction of applicable ITS reliability requirements specified in the NSDB (BSC 2005).

12.2 EXTENDED TESTING

Extended testing, when required, should provide added confidence that ITS reliability requirements can be met with a degree or margin over an operational life. Extended testing should provide a basis for the timing of planned maintenance outages during which components and assemblies would be inspected and maintained.

12.3 SUSTAINED TESTING

Sustained testing, when required, should provide added confidence that ITS reliability requirements can be met with margin for off-normal conditions. Therefore, successful sustained testing should conclude with results that support accelerated and extended testing results.

12.4 OFFSITE INTEGRATED TESTING

Offsite integrated testing will provide assurance the system will perform all required safety functions and that interactions with other equipment interfaces including recovery systems are as specified. During this testing, improvements may be highlighted that will be incorporated prior to delivery and installation of the equipment on site.

13. LOGIC TIES TO DESIGN ENGINEERING, PROCUREMENT, AND CONSTRUCTION

Appendix D identifies logic ties to the design engineering, procurement, and construction schedule. These ties are based on major design development milestones of the DPC cutting machine.

14. REFERENCES

The following documents were used in the preparation of this report:

ANSI/IEEE Std 352-1987. *IEEE Guide for General Principles of Reliability Analysis of Nuclear Power Generating Station Protection Systems*. New York, New York: The Institute of Electrical and Electronics Engineers. TIC: 246332.

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COGEMA 2005a. *DPC and WP Cutting Study Report*, COGEMA-C0115-RP-05-004, Rev. 0. Las Vegas, NV: COGEMA, Inc. (BSC Standard Document No. V0-M00Z-QPA0-05391-00355-001-1).

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APPENDIX A: ITS SSCs DESIGN DEVELOPMENT NEEDS

NSDB Requirement	Applicable SSC	Design Development Needs					Comments
		Required Analysis	Required Drawings	Required Calculations	Required Modeling	Required Testing	
The design of the DPC cutting machine shall ensure that the DPC lid will prevent damage to the SNF assembly resulting in radiological release should the cutting machine fall into or make contact with the DPC.	All load path SSCs	N/A	N/A	N/A	N/A	N/A	Design development satisfied by codes and standards and supplemental requirements
The DPC cutting machine shall preclude a radiological release due to damage inflicted upon the DPC contents during the cutting process.	I&C SSCs, Mechanical SSCs	N/A	N/A	N/A	N/A	Prototype	None
The DPC cutting machine shall be designed for loading conditions associated with a DBGM-2 seismic event and to demonstrate a sufficient seismic design margin to ensure that no failure and no fall down safety functions are maintained for loading conditions associated with a BDBGM seismic event.	All load path SSCs, I&C SSCs	N/A	N/A	N/A	N/A	N/A	Design development satisfied by codes and standards and supplemental requirements

NOTE: BDBGM = beyond design basis ground motion; DBGM = design basis ground motion.

APPENDIX B: ITS SSCS PROTOTYPE TESTING

ITS SSCs Prototype Testing	
ITS SSC	**Test**
Cutting process SSCs • Mechanical • I&C	Specific tests are to be determined as they apply to the NSDB cutting process requirement

APPENDIX C: ITS SSCs DATA COLLECTION

ITS SSCs Data Collection	
ITS SSC	**Potential Data Collection**
No data collection requirements are currently identified. Future requirements may apply for prototype testing as the tests are determined.	N/A

APPENDIX D: DPC CUTTING MACHINE DESIGN DEVELOPMENT MILESTONES

Design Development Activity	Development Activity Description	Project Phase	P3 Logic Tie Activity ID	P3 Logic Tie Activity Description	Target Start	Target Finish
Selection of SSCs	Selection of SSCs for detailed design	Procurement—Development of performance specification Procurement—Detailed design by vendor	RPPDFK20	MH Vendor Design	Sep 2007	Apr 2011
Engineering Calculations	Structural and mechanical design Instrumentation and control and electrical design	Procurement—Detailed design by vendor	RPPDFK20	MH Vendor Design	Sep 2007	Apr 2011
			RPPDFK20	MH Fabrication	Sep 2007	Apr 2011
Computer Modeling	Interference and interface verification Finite element analysis	Procurement—Detailed design by vendor	RPPDFK20	MH Vendor Design	Sep 2007	Apr 2011
Fault Mode and Effects Analysis	FMEA of detailed design	Procurement—Development of performance specification Procurement—Detailed design by vendor	RPPDFK20	MH Vendor Design	Sep 2007	Apr 2011
Fault Tree Analysis	FTA of detailed design	Procurement—Development of performance specification Procurement—Detailed design by vendor	RPPDFK20	MH Vendor Design	Sep 2007	Apr 2011
Bench Testing of Components	Bench testing • Test preparation and procurement • Vendor test	Procurement—Detailed design by vendor	RPPDFK20	MH Fabrication	Sep 2007	Apr 2011
Prototype Testing	Prototype testing • Test preparation and procurement • Accelerated testing • Extended testing • Sustained testing	Procurement—Detailed design by vendor	RPPDFK20	MH Vendor Shop Test	Sep 2007	Apr 2011
Offsite Integrated Testing	Offsite integrated testing (non-radioactive) • Test specification and procedure • Testing	Detailed design by vendor	RPPDFK20	MH Vendor Shop Test	Sep 2007	Apr 2011

NOTE: Only prototype testing is identified as a design development activity for the DPC cutting machine; however, the codes and standards and supplemental requirements given in *DPC Cutting Machine—Gap Analysis Table* (COGEMA 2005b) also cover many of the above activities.

MH = mechanical handling